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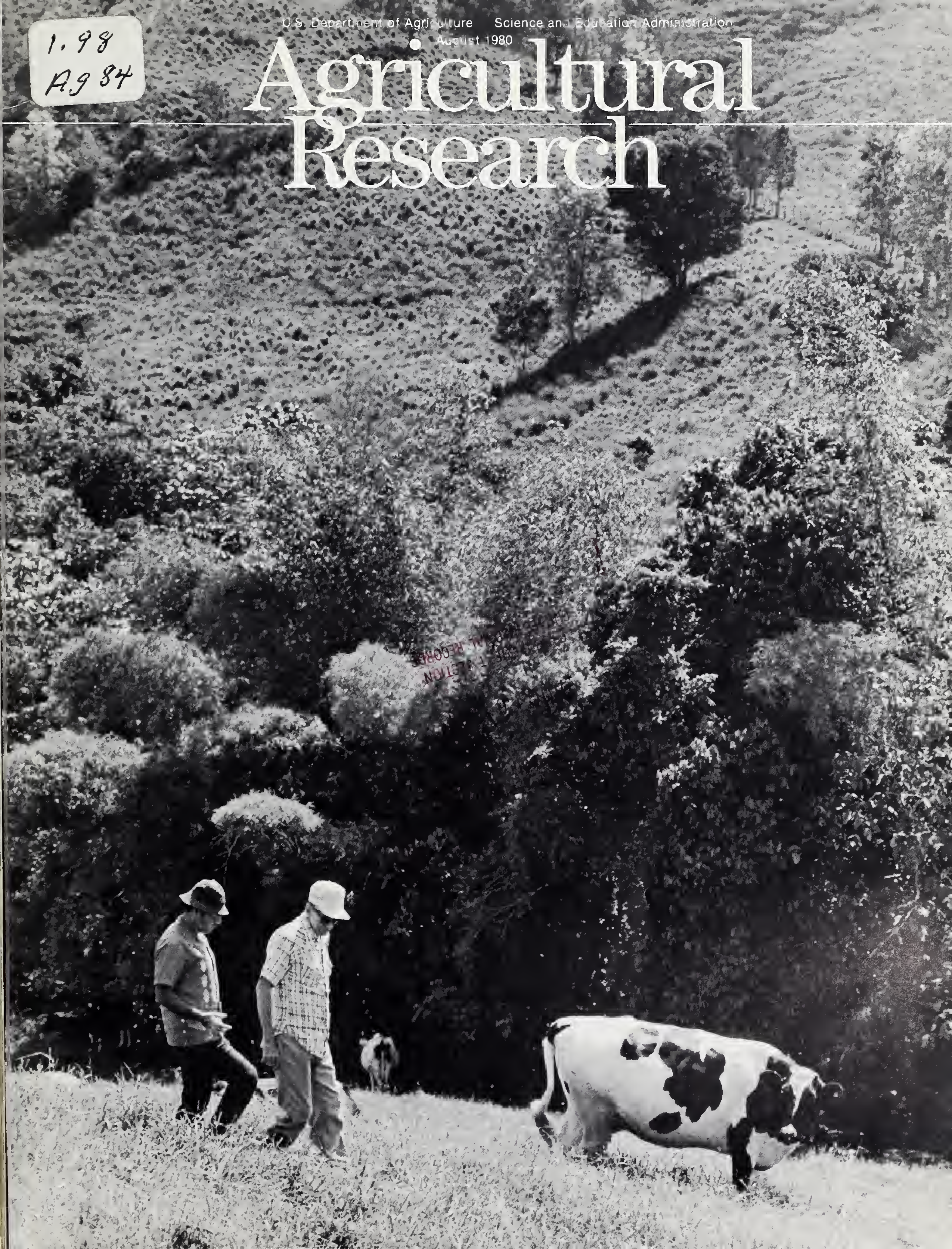

Animal Agriculture— Meeting Human Needs in the 21st Century

At the May 1980 conference "Animal Agriculture—Human Needs in the 21st Century," Anson Bertrand, director of science and education, spoke of the relationships of animal agriculture and research to human needs.

In addressing more than 200 decisionmakers at the Boyne Falls, Mich., meeting, Bertrand also focused on our Nation's land and water resources and productivity in animal agriculture. The following comments are excerpted from these remarks:

In the future, we will not be able to produce the vast acreages of irrigated forages of the past. Irrigation itself consumes about 20 percent of the total energy used in agricultural production, and irrigation costs are increasing dramatically.

It is water—or the lack of it—that may spell the most dramatic changes for animal agriculture. The combination of increasing human needs and decreasing water supplies has set us upon a collision course.

Will we still be able to support 25 percent of the cow herd and the majority of the sheep in the arid and semiarid parts of the country? Or will we see continuing movement of livestock production to the humid regions of the Southeast, where water is not such a limiting factor?

We know that improved bermudas and other tropical grasses such as stargrass, with their great forage yields, are making a tremendous impact on the livestock industry in the South and in Puerto Rico.

The research on feeding dairy cows and beef cattle exclusively on these grass pastures in Puerto Rico is highlighted in the lead article of this issue of Agricultural Research.

What about dependency on N fertilizer for these high yielding forages? Will energy shortages and costs of fertilizer result in revision to low stocking rates in the Southeast? Will we see a continuation of the increased use of range forages such as this, in livestock production? If so, what are the environmental consequences? Recent estimates indicate that more than half of the range in the contiguous 48 states is in unsatisfactory condition. Some areas are in high risk of desertification, with soils so fragile they cannot sustain more intensive use.

And what of the interests of the nontraditional users of rangelands—the environmentalists, the recreationists, and others, who believe that the range is for their use? The conflicts between traditional and unconventional land use on our range land will continue to grow in the 21st century.

What about productivity in animal agriculture? We have achieved many research breakthroughs in animal agriculture—the eradication of hog cholera, the development and application of artificial insemination, and the genetic evaluation of dairy bulls.

Where does productivity fit into our future research goals?

A number of problems in animal reproduction, genetics, nutrition, and disease control are particularly complex and will be difficult to solve. At the same time, there are promising areas that could have important impacts on production efficiency.

For example, we are learning how to obtain and transfer embryos on a routine basis in cattle, and the process now needs to be improved and extended to other animals. Control of the sex ratio and the number of offspring born may be possible within this decade if research progress continues.

We need to continue to improve our ability to evaluate early the genetic worth of animals and to maximize the use of superior germplasm in animal breeding.

Looking to the future, we must be aware of the critical need for basic research information on animals. More investigation is needed at the cellular level, and we need to find ways of utilizing genetic engineering techniques in livestock. The cell and its genetic machinery is vital to every process important in animal production.

While we work in identifying research priorities in terms of human needs . . . keep in mind that the base of fundamental knowledge from which most of us in science are working today is not very great. In fact, it is a very thin foundation.

We are seeing heightened concern for science and education within USDA and an increased level of concern from the President's Office of Science and Technology Policy. Research and science are clearly recognized as fundamental to increasing productivity. Well thought out programs of research on animal agriculture must define the needs and consider the users if they are to find a hearing in the public sector.

The food and agriculture industry of the United States, including the research and education component, faces challenges which will tap its resources and imagination to the utmost. As we move through the last decades of the 20th century and into the 21st, we must learn to make creative decisions that balance our priorities in fairness to all. We will also have to act in a context of a rapidly changing society and economy. We will have to get used to operating in a world of vastly lowered degrees of certainty.

Federal, state, and industry researchers must make whole-hearted efforts to reach agreement on research goals that are of highest priority.

Agricultural researchers need not be reminded that number one on the list of human needs is a dependable food supply. In the United States, that means a food supply that is nutritious, abundant, varied, safe, economical, and good-tasting.

Americans have had that kind of food supply to a greater degree and for a longer period of time than any other people at any other time in the history of this planet. If we are to continue to have it in the 21st century, the science of animal agriculture must be strengthened so that it can continue to play a major role in filling this human need as it has in the past—not only for the people of this country, but for those in much of the rest of the world.

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Photo pp. 8, 14 courtesy Grant Heilman.

Cover: Lush pastureland nestled in the hills of central Puerto Rico surrounds researchers as they inspect recently planted, fast-growing stargrass, *Cynodon nlenfuensis* Vanderyst. This long-lived perennial is now being used as forage throughout the Caribbean to help increase milk and meat production. Our story begins on page 4 (0680X616-15).

Pointing Puerto Rican Agriculture Toward Profit

Milk and meat production based primarily on intensively managed pastures in the humid hill and mountain region may be one answer to Puerto Rico's desire to improve its agricultural industry.

Grain is scarce and expensive in the tropics and will increasingly be required exclusively for human consumption as the population grows, says SEA soil scientist Jose Vicente-Chandler at the Agricultural Experiment Station in Rio Piedras.

One way to produce milk and meat for high quality protein in the human diet, says Vicente-Chandler, is by feeding cattle on grasses. Pastures are excellent for conserving soil on steep lands not suited to other crops, and cows can "harvest" the forage by grazing almost as effectively on steep lands as on level lands.

Rio Piedras researchers began studies on dairy cows fed exclusively on steep grass pastures 15 years ago with a small group of cows. Now the dairy herd numbers more than 150 cows.

"Stargrass, whose fertility and management requirements we have studied for many years, was previously shunned throughout Latin America because of presumed toxicity since it occasionally analyzes high in prussic acid content," says Rubén Caro-Costas, SEA-PR experiment station agronomist. "Our work has shown that not only is this grass not toxic to cattle, but it has outyielded all of our other grasses in terms of milk or meat production. It is being planted throughout Central America and, of course, Puerto Rico.

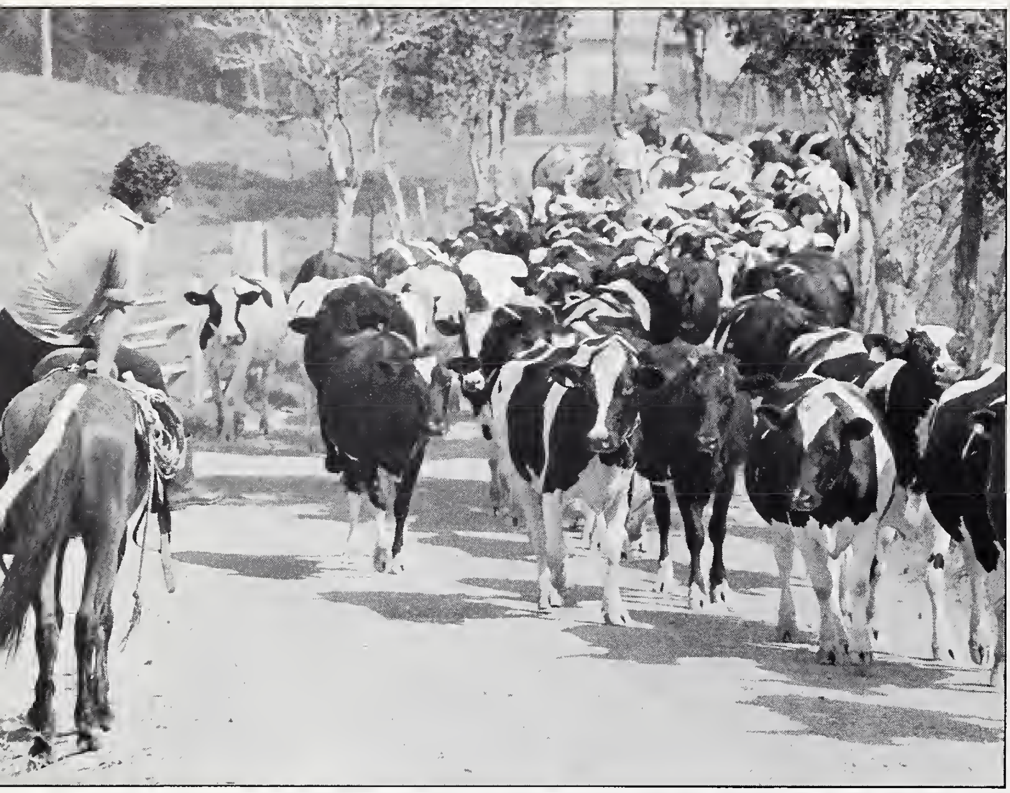
"But problems do exist. For example, most of our milk industry continues to use excessive quantities of imported concentrate feeds—$64 million yearly—mainly because its development was based on an abundance of such feeds from the United States. Also, the feed companies over the years have induced dairy producers to use this simpler method of feeding, rather than having to plant and care for pastures. Dairy producers can pass on the high cost of concentrate feeding to consumers who must buy locally produced fresh milk which is difficult and expensive to ship from the United States. We hope this will change with increasing costs and reduced availability of concentrates," says Caro-Costas.

Above: Agent agronomist Rubén Caro-Costas (left), SEA-PR agricultural experiment station, and SEA horticulturist Heber Irizarry inspect stargrass growth. Stargrass outyields all other Puerto Rican grasses for milk and meat production (0680X615-10A).

Opposite: One of stargrass's advantages is the short time it takes to become well established, says Caro. Runners from planted stem sections quickly blanket barren land, turning it to productive forage in just 2 to 3 months (0680X616-32).

Year-round warm weather, high rainfall, and deep porous soils favor the cattle industry in much of the tropics. Vast areas of rolling and steep lands in these areas require the protection that grasslands can afford. Because this land can be fertilized and limed from the air while grazing cattle do their own harvesting, efficient production can be combined with conservation.

Intensive management of specified tropical grasses, conducted under humid tropical conditions and applied on a commercial scale, resulted in pastures which carried over two 600-pound animals per acre throughout the year. The animals produced over



1,000 pounds of weight-gain yearly—one milk cow producing over 6,600 pounds (3,000 liters) of milk on an all-grass ration.

Practices recommended to obtain these high economic yields from grasslands include: planting of high-yielding nutritious grasses, heavy fertilization and liming, proper weed control, grazing at proper heights and intervals, careful management to reduce seasonal variations in growth, and proper care and management of cattle.

Well-managed grass pastures provide all the protein and energy required for normal growth of heifers, steers, and beef cows, as well as for dairy cows producing about 3,000 liters of milk per lactation (an average of 10 to 12 liters daily), say the researchers. Higher-yielding milk cows, rapidly fattening cattle, and calves require supplementary feeding with high-energy concentrates. All types of cattle can obtain the minerals and vitamins they require from good quality pastures.

Production of all grasses included in the experimental program decreased markedly during the winter season of shorter days and cooler, drier weather. The problem can be helped by management practices such as irrigation, deferred grazing to increase carry-over forage into the winter months, increasing intervals between cuttings or grazings, late fall fertilization, and close grazing of the grass late in the winter.

In a 2-year study, all cows in a commercial dairy located in the humid mountainous region of Puerto Rico were fed exclusively on well-fertilized grass pastures to determine the possibility of producing milk without the use of concentrate feeds.

Approximately 185 acres of grass pastures receiving 1 ton of 15-5-10 fertilizer per acre per year were divided into 18 pastures which were grazed in rotation by a herd of about 185 Holstein cows.

During the trials, 185 lactations were completed by cows fed for the first time on grass alone, and 86 of those cows completed a second lactation for a total of 271 lactations on all-grass rations. The initial 185 lactations on all-grass rations averaged 7,349 pounds of milk over 291 days com-

pared to an average of 8,418 pounds in 292 days for the second lactations.

Fat content of the milk varied from an average of 3.5 percent which compares favorably with an average of 3 percent for first class dairies in Puerto Rico.

Net income for the dairy was about $42,000 yearly. Cost of materials, almost all imported, were 6.7 cents per liter of milk compared to 12.9 cents per liter for a similar dairy. There cows are fed 1 pound of concentrate per liter of milk, which is the average for Puerto Rico.

All the fresh milk consumed in Puerto Rico could be produced on about 200,000 acres of good pasture without imported, concentrate feed. However, Vicente-Chandler advises that pasture feeding is best for producing the first 10 liters per cow each day. After that he suggests feeding 1 or more pounds of concentrates for each additional liter of daily production, depending on the cow's production level.

The scientists' conclusions: Puerto Rico's milk production can be increased with economic benefit to farmers either by expanding the herds and the acreage in pastures or by increasing production per cow by using better quality animals with heavy supplementary feeding of concentrates. However, Vicente-Chandler says, since there is more than enough land suited to pastures in the humid hill and mountain region and since concentrates are imported, the former alternative is more desirable in terms of Puerto Rico's economy.

Analyses of beef cattle enterprises show that feeding out cattle for slaughter or raising dairy replacement heifers, both on full grass rations, are profitable operations.

These are the new directions Vicente-Chandler and colleagues find most promising for the Puerto Rican dairy and cattle industry.

Cooperating with Jose Vicente-Chandler on various studies at the Agricultural Experiment Station, Box H, Rio Piedras, Puerto Rico, 00928, were Rubén Caro-Costas, G. Serra, Fernando Abruña, Jacinto Figarella, and Servando Silva.—(By Peggy Goodin, SEA, New Orleans, La.)

Above: Much of Puerto Rico's hilly terrain is unsuitable for crop production. But it can be used as pasture to ease the cattle and dairy industry's dependence on expensive imported concentrate feeds (0680X618-17).

Opposite Top: Herded to pasture by *vaqueros*, these Holsteins are fed exclusively on stargrass forage. SEA soil scientist Jose Vicente-Chandler says all fresh milk consumed in Puerto Rico could be produced on about 200,000 acres of good pasture—without imported concentrate feeds (0680X615-4A).

Opposite: A modern milking parlor near Orocovis matches the efficient kind of dairy farming which has enabled Puerto Rico to upgrade its agricultural industry and help satisfy its population's ever-growing food demands (0680X618-2).

Root Borer— New Sunflower Pest

A new sunflower pest that does considerable damage to late-planted sunflower has been found in one commercial field in Bushland, Tex., where it infested 72 to 88 percent of plants seeded in mid-June 1979 or later.

SEA entomologist Charles E. Rogers says the larvae of the pest, *Eucosma womonana,* inhabit and bore through the root system of sunflower, separating the epidermis (the surface layer of root tissue) from the rest of the root.

When infested plants are pulled from the soil, the secondary roots and epidermis of the primary root sometimes slough off, says Rogers. Also, infested plants may suddenly wilt and die without showing prior symptoms of infestation.

"Sunflower is a relatively new crop in the Texas southern plains and problems with new insect pests are likely for the next few years," says Rogers. "The time of planting is very important with regard to this pest—planting sunflower early may significantly reduce losses.

"Although I've only observed the pest in one commercial field, it does recur yearly in our research plots in Bushland. We're now studying this root borer to learn more about its biology and life cycle."

Rogers had earlier reported on another sunflower pest, *Phyllophaga lanceolata,* a scarab beetle that had destroyed more than a thousand acres of sunflower crop in west Texas (*Agricultural Research,* December 1978, p. 15). However, the scarab beetle has not proved to be a serious problem, says the researcher.

Dr. Charles E. Rogers is located at the SEA Conservation and Production Laboratory, Drawer 1, Bushland, TX 79012.—(By Bennett Carriere, SEA, New Orleans, La.)

Sunflower Oilseed— The Golden Giant

Not all gold these days is skyrocketing on the world money market. Some of the "gold" is in the burgeoning crop of sunflowers grown for oilseed.

In 1978, 2.8 million acres of sunflowers were harvested in the United States, and in 1979 a record crop was planted on 5.6 million acres. The 1980 planting estimates call for 4 million acres. A long-term expansion potential of 7 million acres is forecast by USDA.

Only about 10 percent of the oilseed-type sunflowers are used in domestic markets. The remainder are exported to European buyers and markets as far away as Egypt. In the United States, several corporations are marketing sunflower-oil margarine and salad and cooking oil.

All this means a bonanza, if not a boom, for sunflower growers.

Where are these growers? They range from North and South Dakota to California, from Canada to Mexico. The heaviest plantings are in the Red River Valley of North Dakota and Minnesota.

To help these growers, SEA chemists at the Russell Research Center in Athens, Ga., studied the effects of planting location and temperature on the average oil content and fatty acid composition of sunflowers. Their first study in 1976 surveyed 10 hybrids and 2 varieties of sunflower (including Hybrid 891, Sunbred 212, Sun Hi 304, and Sputnik 71) grown at 26 locations.

Average *oil contents* ranged from a low of 39.2 percent at Dawson, Ga., to a high of 51.8 percent at Redfield, S. Dak., with an overall average of 46.8 percent. Average *oleic acid* contents ranged from a low of 17.2 percent at Medord, Ore., to a high of 54.2 percent at Gainesville, Fla., an overall average of 34.3 percent. Average *linoleic acid* contents ranged from a low of 37.2 percent at Gainesville, Fla., to a high of 71.2 percent at Morden, Manitoba, an average of 55.7 percent.

"The fatty acid composition of sunflower oil is known to vary with temperature during seed development," says SEA research chemist James A. Robertson. "These fatty acids are considered essential in human and animal nutrition. Linoleic acid, a polyunsaturate, is thought to be generally

Commercial sunflowers in bloom.

desirable for people with heart disease or high blood pressure. It lowers both blood pressure and blood cholesterol. Oil from commercial sunflower varieties has been found to have linoleic acid content ranging from 31.4 percent for plantings in Texas to 75.5 percent for plantings in Canada. Differences in fatty acid composition afford varied uses of sunflower oil. Lower linoleic acid is valuable in oil for frying snack foods, and high linoleic acid oil is preferred in salad oils and margarine."

In the second survey (1977), 12 hybrids and 2 varieties of sunflower were grown at 38 locations. Average oil contents ranged from a low of 37.6 percent at Rio Bravo, Mexico, to a high of 51.8 percent at Brooksville, Miss., an overall average of 46.3 percent.

For both years, temperature and latitude had a highly significant effect on fatty acid composition. Sunflowers planted by June 1 at 39° latitude or above generally had linoleic acid contents of above 60 percent. Plantings below 39° latitude had linoleic acid contents below 60 percent.

Temperature and latitude had no significant effects on total oil contents. "Sunflowers grown at the cooler locations and at latitudes above 39° had slightly higher oil contents than those grown at the warmer locations, below 39°," says Robertson.

These observations show oil buyers where to shop. Sunflower oil for products requiring high polyunsaturated oil, such as margarine and salad dressing, might be obtained from planting locations above 39° latitude. Sunflower oil used in snack food frying (potato chips, french fries) might be obtained from plantings below 39°.

Does this put the Southern farmer at a disadvantage for the premium market? After all, oil produced in the South contains 40-50 percent linoleic acid, and is therefore high in monounsaturated fats. To a degree it does, says Robertson, but the Southern farmer could conceivably grow two crops and thus tailormake the linoleic acid content. The first plantings would be followed by a second in August when the sunflower could mature with cooler fall weather. Late plantings of sunflowers in south Texas have had linoleic acid contents as high as 75 percent.

Dr. James A. Robertson, Dr. W. Herbert Morrison III, and biometrician Ruel L. Wilson conducted the study at the SEA Russell Research Center, P.O. Box 5677, Athens, GA 30604.—(Peggy Goodin, SEA, New Orleans, La.)

Resistant Wild Sunflower

SEA scientists have found four wild species of sunflower resistant to head rot—the most destructive disease of cultivated sunflower in Texas.

"Head rot is a fungus that causes sunflower heads to rot and fall to the ground. It's particularly destructive when plants are predisposed to infection by mechanical injury," says SEA plant pathologist Shaw-Ming Yang. Yang worked with agricultural technician John B. Morris and research geneticist Tommy E. Thompson on evaluating sunflower for resistance to head rot.

All of the cultivated sunflower varieties tested, including some from other countries, were susceptible to the fungus disease, but some wild varieties showed a high degree of resistance. When the scientists deliberately injured the wild plants with forceps and infected them with the fungus, the plants were able to limit the disease to the site of the injury.

"This means we might be able to control head rot through breeding for resistant varieties of commercial sunflower. Also, this test shows the value of further screening of sunflower for resistance," says Yang.

Sunflower is an increasingly important oilseed crop, especially in the semiarid areas of the country. Because of an extensive root system that can penetrate a large volume of soil to extract water, sunflower has good drought resistance. The cash value of this crop is increasing yearly; consequently, the cost of destructive diseases like head rot is also increasing dramatically.

Dr. Shaw-Ming Yang is located at the SEA Conservation and Production Laboratory, Drawer 1, Bushland, TX 79012.—(By Bennett Carriere, SEA, New Orleans, La.)

Artificial Nose Detects Potato Disease

A human can easily detect volatile substances emitted by rotting potatoes, but not early enough to prevent disease and subsequent crop loss.

Research on a chemical method for early detection of potato disease is being conducted at the SEA Red River Valley Research Laboratory in Grand Forks, Minn. Losses of stored potatoes due to disease may be as high as 30 percent in many parts of the country, says Jerry L. Varns, biochemist at the research laboratory.

Potatoes in storage and organisms that cause potato diseases, like all living organisms, give off unique combinations of volatile substances into the atmosphere as they respire, says Varns. He has found, for example, that the volatiles from potatoes with bacterial soft rot contain higher proportions of ethanol, acetone, and 2-butanone than do volatiles from healthy potatoes.

These volatiles may have a mild undisturbing or even pleasant smell, Varns says, but soft rot paves the way for infections by secondary disease organisms. And as the diseases spread, the smell of rotting potatoes becomes powerful. If the disease problem could be detected early, growers or processors could immediately take the potatoes out of storage and have most of the tubers used instead of wasted.

Varns developed a way to concentrate minute amounts of the tell-tale volatiles before soft rot becomes prevalent enough to be smelled by humans. To do this, he liquified air samples from the storage atmosphere in high-pressure cylinders immersed in liquid nitrogen.

He further concentrated the liquified volatiles in a hydrophobic absorbent material which, when heated, yielded the volatiles back into a gaseous state to be analyzed in a gas chromatograph.

Chemist John Linkletter uses a liquid nitrogen vacuum system to collect air samples containing potato disease volatiles. The cold (– 195.8°C) nitrogen liquifies the gases for storage until later analysis. Early detection and identification of disease gases could save thousands of dollars annually in losses of potatoes stored in an average commercial-size bin (0777B918-11).

The chromatograph produces a chromatogram, or "fingerprint," that reveals the presence and concentrations of separate volatiles.

Varns has identified more than 20 volatiles in his studies aimed at finding chromatograms that are characteristic of potatoes with specific diseases or different varieties of healthy potatoes. This research in the laboratory and at commercial bins is conducted in cooperation with the Minnesota and North Dakota Agricultural Experiment Stations and the Red River Valley Potato Growers' Association.

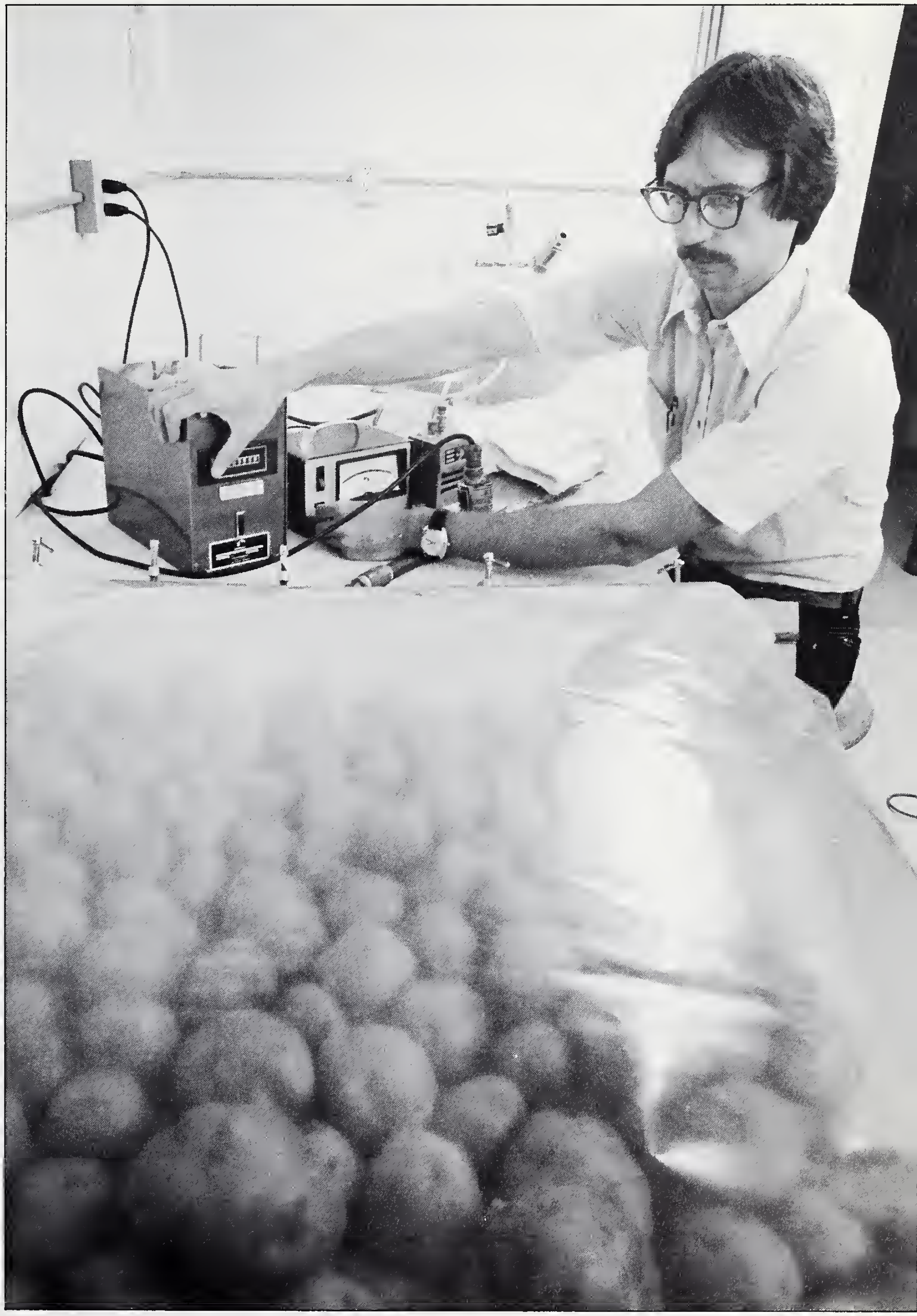
Monitoring of volatiles could become an important early warning of potato disease problems. But, Varns says, this would supplement rather than replace good storage techniques. Good managers typically keep a close watch on temperature, humidity, and ventilation and they frequently observe trenches in the bottom of bins and the surface of the potato pile for signs of trouble.

Healthy potatoes emit hydrocarbons and the concentrations of these and other volatiles are highest in bins that have the least ventilation, Varns found. But he also found that the proportions of ketones, mercaptans, and aldehydes in relation to hydrocarbons were consistently greater in bins with diseased potatoes, regardless of ventilation, than in bins containing healthy potatoes.

Before sampling and analysis of potato volatiles is adopted by the potato industry as a disease diagnostic technique, equipment could be designed that will monitor only one or two important volatiles, Varns suggests. This equipment would be more affordable by the users.

"Most growers probably would be willing to spend several thousand dollars for equipment that would monitor the condition of potatoes in storage every couple of days," Varns says. "Potatoes in a typical commercial-size bin in the Red River Valley are worth $50,000 to $100,000."

But cutting disease losses in storage is only one of several applications of volatile monitoring that Varns envisions. Seed potatoes could be screened for diseases that cause poor crop stands. The monitoring could also



Biochemist Jerry Varns takes volatile samples from potatoes "quarantined" in clamped Teflon bags containing ultra-pure air. In the lab, potatoes are isolated from outside gases for 24 hours before sampling (0777B916-25).

identify stored potatoes that have poor prospects for use after long-term storage because of a stressful growing season or unbalanced soil fertility.

A volatile that accumulates in the storage atmosphere and subsequently disappears was found in Varns' laboratory studies and at commercial bins during suberization—a critical process in which potato skins thicken during the first week or two of storage. This volatile could be an important indicator of good prospects for successful long-term storage.

If suberization is thorough and quick, Varns says, wounds that are inflicted on potatoes during harvesting and storing have the best chance to heal and these tubers are less susceptible to diseases late in storage. But because the warmth and moisture that favor suberization are the same conditions that favor immediate disease development, storers don't want to allow these conditions to exist any longer than necessary.

Varns suggests that volatile monitoring could help storers know when suberization is complete so they will know how soon to modify temperature, humidity, and ventilation in the bins.

The composition of potatoes changes throughout the time of storage. These changes directly affect their suitability for processing into various potato products. "Decisions on potato usage may be made with improved accuracy as we gain insights through further research involving microprocessing of data on volatiles," Varns says.

Dr. Jerry L. Varns is located at the SEA Red River Valley Potato Research Laboratory, P.O. Box 113, E. Grand Forks, MN 56721.—(By Ben Hardin, SEA, Peoria, Ill.)

Top: Martin Glynn, North Dakota State University lab technician, draws volatile gas collected from potato storage bins for analysis by gas chromatography. The chromatograph "fingerprints" the volatiles, revealing their presence and concentration for disease detection (0777B917-15).

Right: Linkletter monitors volatile density in air surrounding a *Fusarium* culture. By comparing volatiles of isolated diseases, scientists can pinpoint volatile differences. Further comparison between isolated volatiles and those collected from bins are instrumental in diagnosis and treatment of potato disease (0777B918-34).

Sicklepod Stands Up To The Sun

How important is the time of day to application of weed control chemicals?

It depends on which weed you are trying to kill, according to SEA weed scientist Robert N. Andersen.

For sicklepod, a weed common in field crops in the southeastern United States, herbicide spray treatments were nearly twice as effective when applied during the middle of the day than when applied in the evening, night, or early morning.

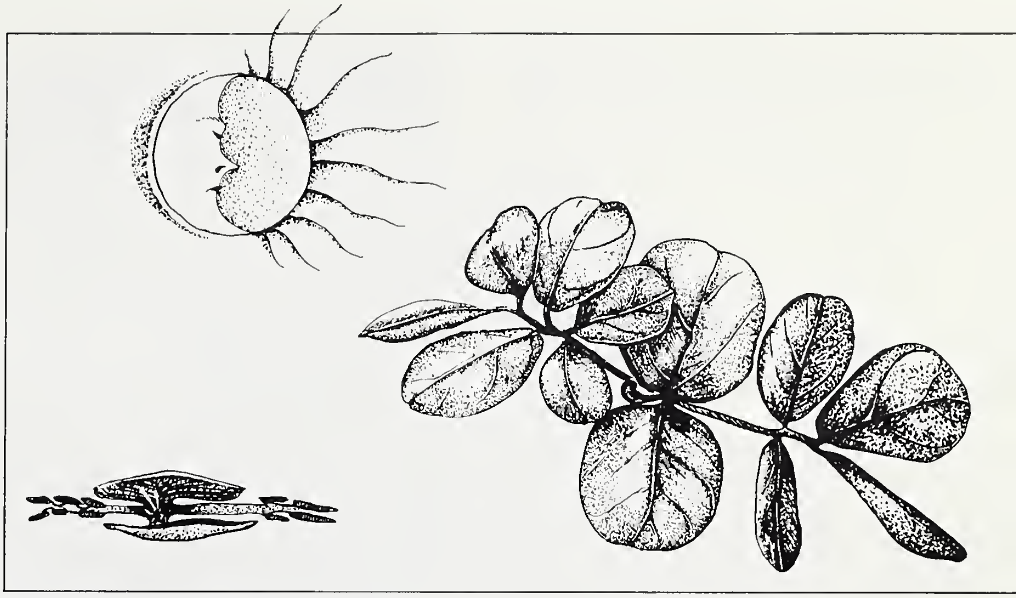
Andersen, stationed at the University of Minnesota, St. Paul, Minn., and Gary W. Kraatz, graduate student, selected the weed for detailed field studies because evidence from earlier research indicated sicklepod might show significant differences in response to day and night herbicide treatment.

When sicklepod leaflets fold together and droop, as they do from evening to early morning, the leaf area exposed to an herbicide spray from directly above the plant is only about 14 percent of the area exposed when the leaves are fully extended as they are during the middle of the day, Andersen says.

The researchers evaluated sicklepod plants treated with herbicide at different times of the day and night.

"Our results clearly suggest that leaf changes related to the time of day can be an important factor in the efficiency of some herbicide treatments on some species of weeds," Andersen says.

In earlier research, Andersen and University of Minnesota plant physiologist Willard L. Koukkari found that all velvetleaf plants sprayed with herbicide at mid-day were killed, but only 28 percent control was obtained when plants were treated during the "sleep" period (*Agricultural Research,* July 1978 p. 8).



Sicklepod responds differently to night-and-day time herbicide treatments (PN-6810). Art: Lisa M. Bell

In other research, Andersen and Koukkari evaluated the leaf movements of nine weed species in growth chambers under several different light-dark schedules. They studied wild mustard, redroot pigweed, black nightshade, jimsonweed, common lambsquarters, common cocklebur, prickly sida, sicklepod, and coffee senna.

Every 3 hours the researchers measured the angles of the leaves in relation to the stem, the ground, and to other leaves. All the plants except wild mustard showed a systematic reaction to light conditions. Wild mustard showed erratic leaf movements, but they were unrelated to light conditions, Andersen says.

While the other plants showed various reactions, some moving their leaves upward under dark conditions while others dropped downward, the leaf angles might affect the results of herbicide spray application to some degree.

Because of extreme leaf movements, both sicklepod and coffee senna would be expected to intercept much less herbicide from an over-the-top spray application when they were in the "night" position than they would in the "day" position, Andersen says.

"Kraatz's specific studies of sicklepod show a very significant reduction in the effectiveness of herbicide applications from evening through early morning as compared to other times of application during the day," Andersen says.

Dr. Robert N. Andersen is located at the Weed Research Laboratory, University of Minnesota, St. Paul, MN 55018. —(By Ray Pierce, SEA, Peoria, Ill.)

Narrow-Row Cotton Aids Growers

Narrow-row cotton—requiring 14 inches rather than 40 inches between rows—benefits growers in three ways: it yields more cotton per acre, has earlier harvest dates, and plays a role in integrated pest management schemes.

Narrow-row cotton yielded 3,600 pounds per acre compared to 3,000 pounds per acre on conventional 40-inch beds in studies in the Imperial Valley of California. That figure was for the harvest date of August 24. Vilas T. Walhood, SEA plant physiologist, Shafter, Calif., conducted the studies. The yield was a 19 percent increase over conventional rows.

Walhood found that when irrigation and insecticide treatments were continued through September, yields amounted to 5,700 pounds per acre from the narrow rows and 4,750 from the 40-inch rows. That harvest date was Nov. 5.

The increase in yield is attributed to the more efficient use of sunlight in the photosynthetic process early in the season, Walhood says. Cotton plants in narrow rows leaf out between rows and take advantage of sunlight that much of the time falls on bare ground in conventional rows.

The early harvest dates could allow growers to "terminate" the growth of late season bolls early. After harvest, the crop can be plowed down before the pink bollworm, a devastating cotton pest, is prepared for overwintering and earlier than the plow-down date set by state regulation in California. Those late-season bolls add nothing to cotton lint yield, but are favored by pink bollworm insect larvae as an overwintering spot. Those overwintering in-

sects make up the nucleus for the pink bollworm populations the following spring. By ridding the fields of the bolls and plowing down the cotton stalks, growers can reduce the size of the spring "crop" of pink bollworms.

The pink bollworm is one of the most destructive pests of cotton throughout the world, causing millions of dollars in crop losses and costing many millions to control.

Narrow-row cotton may not be readily accepted by growers because present pickers are geared to 40-inch rows. While pickers are now available for narrow-row cotton, the idea may have to wait until present high-cost equipment needs replacement.

Dr. Vilas T. Walhood is stationed at the U.S. Cotton Research Station, 17053 Shafter Avenue, Shafter, CA 93263.—(By Paul Dean, SEA, Oakland, Calif.)

Pima Cotton Advances

An ongoing SEA research program on long-staple high quality Pima cotton is lessening the yield differences between Pima and short-staple upland cotton without sacrificing quality.

Usually, when plant breeders set their sights on quantity, quality suffers. Not in the case of Pima. In fact, in the El Paso, Tex., marketing area that includes cotton growers in Texas, New Mexico, and eastern Arizona, Pima actually outyielded upland cotton in 1977. In Texas, upland netted an average 617 pounds per acre compared to 751 pounds for Pima. In New Mexico, it was 603 to 621 and in eastern Arizona it was 648 to 695.

Long-staple cotton, like Pima, goes into the manufacturing of high quality thread, yarn, and cloth, and growers receive premium prices for the lint. Upland's attractiveness to growers has been its quantity of yield.

A variety of Pima, called S-5 by plant breeders and growers and released for commercial use in 1975, accounted for 97 percent of the Pima acreage in 1978. It was the fourth consecutive year for the cultivar—rising from 10 percent in 1975, 80 percent in 1976, and 94 percent in 1977.

"When Pima S-5 was released, it was the most productive, earliest maturing and shortest statured cultivar we had tested throughout the Pima belt," says SEA agronomist Carl V. Feaster.

Pima S-5 may be outclassed, however, in several areas by some of its descendants now in the process of being tested by Feaster throughout the Pima belt.

Two of those cultivars look especially promising, Feaster says, in that they outyield Pima S-5, mature earlier, and are shorter in stature.

"Early, productive, short-statured cultivars are essential to the short-season concept for reducing production costs, and that type of plant is adapted for integrated pest management schemes," Feaster says.

Dr. Carl V. Feaster is located at the SEA Cotton Research Center, 4207 E. Broadway Road, University of Arizona, Phoenix, AZ 85040.—(By Paul Dean, SEA, Oakland, Calif.)

Combining Cotton Insect-Resistant Characters

Two or more low-level pink bollworm resistant characters combined into one cotton variety could substantially reduce the use of pesticides on that crop.

The pink bollworm is the major pest in Arizona and the desert valleys of California. Chemicals provide the most effective control at present. However, effectiveness of chemical control is somewhat limited. Newly hatched pink bollworm larvae bore into the developing bolls and once inside are protected from further chemical treatment. Natural resistance avoids that problem.

SEA plant geneticist F. Douglas Wilson of Phoenix, says several natural pink bollworm resistant characters have already been identified in cotton plants.

"None of the characters, however, provide enough resistance alone to allow cotton growers to stop using insecticides," Wilson says.

"The possibility is good that we can combine some of those features and develop a cotton variety that has a high percentage of resistance to pink bollworm.

"In fact, two characters that have already been combined—nectariless (nectaries are spots or organs on plants that provide nectar and water as nourishment for insects) and smooth leaf (hairless)—caused a substantial decrease in pink bollworm damage to cottonseed," Wilson says.

Dr. F. Douglas Wilson is at the SEA Cotton Research Center, 4207 E. Broadway Road, University of Arizona, Phoenix, AZ 85040.—(By Paul Dean, SEA, Oakland, Calif.)

Harvesting cotton on a USDA test plot near Phoenix, Arizona (0176X18-34A).

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Agrisearch Notes

Alfalfa and Herbicides. Alfalfa growers who suffer yield losses after using herbicides on their crops should have their soil sampled for root-knot nematodes. SEA greenhouse tests indicate that using certain herbicides on nematode-infested alfalfa increases the damage nematodes inflict on the alfalfa.

Normally, the root-knot nematode, a microscopic, snakelike animal, poses a bigger threat to crops used in rotation with alfalfa than to the alfalfa. Though the nematode does attack alfalfa roots, it uses the plant primarily for breeding.

The SEA tests show that herbicides put a stress on alfalfa plants that increases their susceptibility to root-knot nematode infection and pathogenicity. Even supposedly nematode-resistant alfalfa varieties are damaged under the combination of nematodes and chemicals.

SEA plant pathologist Gerald D. Griffin and J. LaMar Anderson, a plant scientist with Utah State University, both located at Logan, conducted the greenhouse tests. To two popular alfalfa selections—nematode-susceptible Ranger and nematode-resistant Nev Syn XX, the researchers applied root-knot nematodes and three herbicides widely used to control weeds in alfalfa: DCPA, EPTC, and chlorpropham.

Growth of Ranger was reduced 38, 80, and 94 percent from combinations of nematodes and DCPA, EPTC, and chlorpropham, respectively. Nev Syn XX showed yield losses of 47, 85, and 93 percent. These losses were under greenhouse conditions and wouldn't be as severe in the field, says Griffin, but he maintains that a trend has been established.

Growers extensively use herbicides in both seedling and established alfalfa plantings. Many of these plantings are infested with root-knot nematodes, so growers should be made aware of the potential problems.

Dr. Gerald D. Griffin is located at the SEA Crops Research Laboratory, Room 215, Utah State University, Logan, UT 84322.—(By Lynn Yarris, SEA, Oakland, Calif.)

Quick-Cooking Brown Rice. SEA scientists have developed a quick-cooking brown rice that can be prepared in the home in one-fourth the time of regular (raw) brown rice. And like regular brown rice, this product is more nutritious than white rice. It contains 20 percent more protein, 7 to 9 times the vitamins, and twice the minerals of white rice.

Brown rice is that color because it is not milled as white rice is and so still retains the darker bran and aleurone layers. These outer layers contain the valuable nutrients—high quality protein, vitamins, and trace minerals.

"Because home preparation takes 10 to 15 minutes, it can't be considered an 'instant' rice like some of the white rice products on the market. But this quick-cooking brown rice will be more convenient for persons who want a more nutritional rice in their diets," says SEA chemical engineer Robert Carlson, Berkeley, Calif.

"Drying time during processing is about half that required in existing commercial quick-cooking processes for white rice, and drying is at a lower temperature. In addition to nutritional advantages, there is significant energy saving. Additional energy savings also come from reduced milling requirements and from less cooking time at home," adds Carlson at SEA's Western Regional Research Center.

The innovatively processed brown rice and significant energy reductions were realized through use of specialized drying equipment originally developed at the center for drying fruits and vegetables.

Taste panel tests indicated that the quick-cooking brown rice is comparable to conventionally prepared brown rice. Brown rice has a more pronounced flavor than white rice, somewhat akin to the taste difference between whole wheat bread and white bread.

Dr. Robert Carlson is located at the SEA Western Regional Research Center, 800 Buchanan St., Berkeley, CA 94710.—(By Dennis Senft, SEA, Oakland, Calif.)